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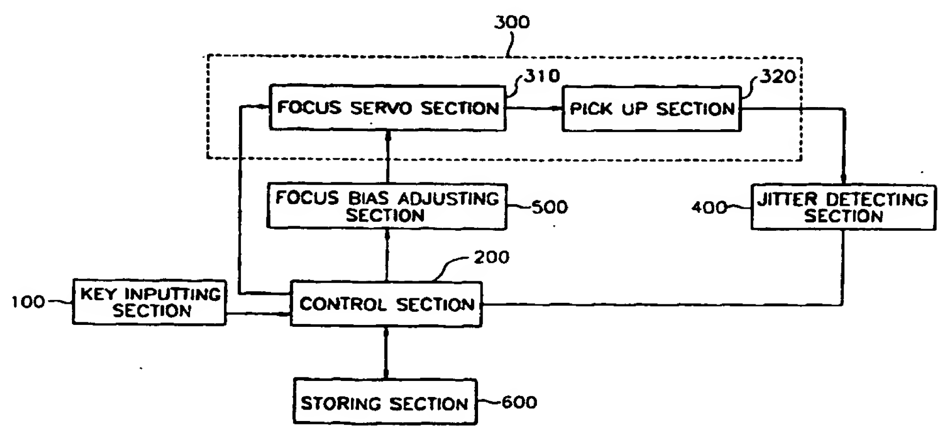

(57) Abstract

A method and an apparutus for automatically adjusting a focus bias are disclosed. A table–up data of a focus bias variation to a magnitude of a jitter deviation is stored in a memory. A first jitter generated by a predetermined focus bias is detected during a predetermined time for reproducing optical disc information, and the first jitter is stored. After this, a second jitter, generated during a predetermined time for reproducing optical disc information, is detected after adjusting the focus bias to the maximum of an adjustable value. Next, once a deviation between the first jitter and the second jitter is calculated, a third jitter is detected by referring to the table–up data after adjusting a focus bias as much as a focus bias variation corresponding to the calculated jitter deviation. Then, a current focus bias value to adjust the focus bias is maintained to be applied in the condition that the first jitter has a greater value than that of the third jitter. In the opposite condition, feed backing to the step which calculates the deviation between the first jitter and the second jitter occurs. Consequently, an auto–adjustment for the just–in–focus state can be achieved, and thereby the original signals can be produced by preventing a false action such as a ghost in the output picture and noise occurring in the output sound.

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METHOD AND APPARATUS FOR AUTOMATICALLY ADJUSTING A FOCUS BIAS VOLTAGE

Technical Field

The present invention relates to an automatic adjustment of a focus bias in an optical disc system, and more particularly to a method for automatically adjusting a focus bias and an apparatus for performing the method suitable for a focus servo system of an optical disk player, like a compact disc (CD) player, for reading information recorded on a disk in the form of an optical signal.

Background Art

With the outstanding progress of audio/video recording media, various types of optical disc players have been developed, which record audio/video signals on semipermanent optical discs and reproduce these recorded audio/video signals. As to the optical disc players, a compact disc player (CDP), a laser disc player (LDP), a compact disc graphic player (CDGP), a video compact disc player (VCDP) and the like can be enumerated to show how widely they have been used. Such optical disc players can output video and/or audio signals recorded on the optical discs by speakers rather than by video and/or audio reproducing equipments. Having a higher signal-to-noise ratio (SNR) than conventional video and/or audio reproducing equipments, the optical disc players can reproduce signals with a better quality in a picture and a sound, and prevent noises caused by irregular reproduction and unstable modulation from occurring. They have further advantages that their output signals have little distortion and ghost and that a random access operation is available. Due to the above mentioned preferences-advantages, the optical disc players have been developed rapidly and promulgated widely.

Meanwhile, for the precise readout of a program recorded on the optical disc in the optical disc player, a signal surface of the optical disc should be located within a focus depth of a laser beam irradiated from the optical pick-up unit, for which a focus bias adjustment and a focus servo are necessary. The focus bias adjustment adjusts the signal surface of the optical disc to be located within the focus depth of the laser beam and the focus servo adjusts a beam focus to a minute variation in a

disc equilibrium when the signal surface of the optical disc is located within a predetermined focus depth of the laser beam.

There are two waveforms in FIGs. 1a and 1b. FIG 1a shows a waveform in a condition that a focus bias between a reproducing signal and a recorded signal of the optical disc are adjusted and FIG 1b shows a waveform that is not adjusted. In FIG.1a, if the focus bias is precisely adjusted to a just-in-focus state, transition points between the reproducing signal and the recorded signal will have no difference in a time axis. Otherwise, in an out-of-focus state, the transition points between these two signals have a phase difference in the time axis as shown in FIG. 1b. This phase difference (Δt) between the two signals, i.e. the reproduction signal and the original signal, causes a jitter to result in an high error ratio of the reproduction signal. Consequently, when a digital signal recorded on the optical disc is reproduced, the picture displays a false state and/or the sound includes noise.

Disclosure of Invention

Therefore, the present invention is intended for overcoming the above described disadvantages.

A first object of the present invention is to provide a method for automatically adjusting a focus bias in an optical disc player capable of automatically adjusting the focus bias by using a jitter deviation corresponding to a degree of a focus bias adjustment.

Further, a second object of the present invention is to provide a method for automatically adjusting a focus bias value by using experimental data of the focus bias value, which were stored in advance, capable of minimizing a jitter to every range of a jitter.

A third object of the present invention is to provide a method for automatically adjusting one focus bias by using an arithmetical mean value of a focus bias voltage when a positive maximum jitter is detected, and adjusting another focus bias voltage when a negative maximum jitter is detected, after detecting a jitter deviation corresponding to a degree of a focus bias adjustment.

Furthermore, a fourth object of the present invention is to provide a method for automatically adjusting a focus bias of an optical disc player, capable of

adaptively responding to a characteristics of an optical pick-up system, by adjusting the focus bias with a focus bias voltage where a jitter becomes minimized.

A fifth object of the present invention is to provide an apparatus for automatically adjusting a focus bias of an optical disc suitable for performing the above-mentioned methods.

The first object can be achieved by a method for automatically adjusting a focus bias of an optical disc player, which comprises the steps of:

(i) storing a table-up data of a focus bias variation to a magnitude of a jitter deviation;

(ii) detecting a first jitter which is generated by a predetermined focus bias during a predetermined time for reproducing optical disc information, and storing the first jitter;

(iii) detecting a second jitter which is generated during a predetermined time for reproducing optical disc information after adjusting a focus bias to the maximum of an adjustable value;

(iv) calculating a deviation between the first jitter and the second jitter;

(v) detecting a third jitter after adjusting a focus bias as much as a focus bias variation corresponding to the calculated jitter deviation by referring to the table-up data; and

(vii) adjusting the focus bias with a focus bias value to which is currently applied in the condition that the first jitter has a greater value than that of the third jitter, and otherwise feed backing to the step (iv), from a comparison between the first jitter and the third jitter.

In order to achieve the second object of the present invention, a method for automatically adjusting a focus bias of an optical disc player comprises the steps of:

(I) storing a focus bias value, which is a value corresponding to a range of a jitter, capable of minimizing the jitter as a table-up data;

(II) detecting the jitter of the optical disk player by reading out a radio frequency signal from a loaded optical disc;

(III) obtaining, with reference to the table-up data, the focus bias value corresponding to the jitter detected in step (I); and

(IV) adjusting the focus bias of the optical disk player by using the focus bias

value obtained in step (III).

A method aiming at the third object for automatically adjusting a focus bias of an optical disc player comprises the steps of:

(A) storing a table-up data of a jitter magnitude corresponding to each of multiple focus bias voltages;

(B) searching for a first focus bias voltage in which a positive maximum jitter is detected from the table-up data, decreasing the first focus bias voltage as a predetermined voltage to adjust the focus bias, and detecting a first jitter;

(C) searching for a second focus bias voltage in which a negative maximum jitter is detected from the table-up data, increasing the second focus bias voltage as a predetermined voltage to adjust the focus bias, and detecting a second jitter;

(D) calculating an average focus bias value of the first focus bias voltage and the second focus bias voltage;

(E) calculating a positive jitter variation which is a difference between the positive maximum jitter and the first jitter, and calculating a negative jitter variation which is a difference between the negative maximum jitter and the second jitter; and

(F) amending the average focus bias value, capable of reducing a detected jitter, by using the positive jitter variation and the negative jitter variation, and adjusting the focus bias with the amended focus bias voltage.

To achieve the fourth object, a method for automatically adjusting a focus bias of an optical disc player comprises the steps of:

(a) providing a focus servo circuit with a first focus bias voltage in the condition that a first jitter of a radio frequency signal, which is detected first after loading an optical disc, is greater than a reference jitter, and detecting a second jitter of the radio frequency signal corresponding to the first focus bias voltage;

(b) providing the focus servo circuit with a second focus bias voltage in which a predetermined voltage is added to the first focus bias voltage in the condition that the second jitter is greater than the reference jitter and that the first jitter is greater than the second jitter, and detecting a third jitter of the radio frequency signal corresponding to the second focus bias voltage;

(c) setting a third focus bias voltage, as a focus bias voltage, which is an addition of half of the predetermined voltage to the second bias voltage in the event

that the third jitter, detected in step (b), is greater than the reference jitter and that the second jitter is greater than the third jitter, and setting a fourth focus bias voltage, as a focus bias voltage, which is an subtraction of half of the predetermined voltage from the second bias voltage in the event that the third jitter, detected in step (b), is greater than the reference jitter and that the second jitter is smaller than the third jitter;

(d) providing the focus servo circuit with a fifth bias voltage which is a subtraction of double the predetermined voltage from the first bias voltage in the event that the second jitter is greater than the reference jitter and that the first jitter is smaller than the second jitter, and detecting a fourth jitter of the radio frequency signal which corresponds to the provided fifth bias voltage;

(e) setting a sixth focus bias voltage, as a focus bias voltage, which is an addition of half of the predetermined voltage to the fifth bias voltage in the event that the fourth jitter, detected in step (d), is greater than the reference jitter and that the second jitter is greater than the fourth jitter, and setting a seventh focus bias voltage, as a focus bias voltage, which is an subtraction of half of said predetermined voltage from said fifth bias voltage in the event that the fourth jitter, detected in step (d), is greater than the reference jitter and that the second jitter is smaller than the fourth jitter; and

(f) setting each of bias voltages, as a focus bias voltage, which corresponds to the first to the fourth jitters in the event that each of the first to the fourth jitters is smaller than the reference jitter in steps (a) to (e).

Furthermore, to achieve the fifth object of the present invention, an apparatus for automatically adjusting a focus bias of an optical disc player comprises:

a key input section;

an optical disc player, outputting a reproduction signal, including an optical pick-up section for detecting data and a focus servo section for focusing a servo corresponding to a voltage level of a focus error signal after detecting the focus error signal from an electric signal that controls the focus servo section and that is outputted from the optical pick-up section;

a jitter detector for detecting a jitter that is an reading error of a data, recorded on an optical disc, triggered by an inaccurate adjustment of a focus bias

arising from a voltage for the focus bias for whom the optical disc player provides;

a focus bias adjusting section for adjusting the focus bias to locate a surface level of the optical disc within a focus depth of a laser beam of the pick-up section by providing the focus bias voltage for the optical pick-up section; and

a system controller for controlling the optical disc player that corresponding to the signals provided by the key input section and the jitter detecting section.

Brief Description of the Drawings

The above objects and other advantages of the present invention will become more apparent by describing in detail preferred embodiment thereof with reference to the attached drawings, in which:

FIG. 1a is a waveform showing that a reproduction signal of and an original signal of an optical disc were adjusted to their focus bias;

FIG. 1b is a waveform indicating that a reproduction signal of and an original signal of an optical disc were not adjusted to their focus bias;

FIG. 2 is a block diagram illustrating an apparatus for automatically adjusting a focus bias of an optical disc player according to the present invention;

FIG. 3 is a flowchart describing a method for automatically adjusting a focus bias in an optical disc player according to the first embodiment of the present invention;

FIG. 4 is a flowchart explaining a method for automatically adjusting a focus bias in an optical disc player according to the second embodiment of the present invention;

FIG. 5 is a flowchart illustrating a method for automatically adjusting a focus bias in an optical disc player according to the third embodiment of the present invention;

FIG. 6 is a graph depicting a jitter ?with /corresponding to a variation of a focus bias voltage in the third embodiment of the present invention; and

FIGs. 7a and 7b are flowcharts illustrating a method for automatically adjusting a focus bias in an optical disc player according to the fourth embodiment of the present invention.

Best Mode for Carrying Out the Invention

According to preferred embodiments of the present invention, methods for automatically adjusting a focus and an apparatus for carrying out these methods will be explained in more detail with reference to the accompanying drawings.

FIG. 2 shows a block diagram of an apparatus according to the present invention. Referring to FIG. 2, the apparatus includes a key input section 100, a system controller 200, an optical disc player 300, a jitter detecting section 400, a focus bias adjusting section 500, and a data storing section 600.

The key input section 100, having a plurality of function keys such as a power key and a program selection key and so on, provides key signals for the system controller 200 by responding to a user's key selections. Responding to the signals provided by the key input section 100 and the optical disc player 300, the system controller 200 controls an operation of the optical disc player 300. In particular, the system controller 200 controls the operation of the focus bias adjusting section 500 by responding to the variation of the focus bias that corresponds to a jitter deviation stored in the data storing section 600 and in the jitter provided by the jitter detecting section 400.

The optical disc player 300, including a focus servo section 310 and an optical pick-up unit 320, performs a reproducing mode by means of a control of the system controller 200, and provides reproduction signals for the jitter detecting section 400.

The jitter detecting section 400 detects jitters from reproduction signals provided by the optical disc player 300, and provides the detected jitters for the system controller 200.

The focus bias adjusting section 500 is a sort of bias voltage supplier. By means of the control of the system controller 200, the focus bias adjusting section 500 applies a bias voltage to the optical pick-up unit 320 installed in the optical disc player 300, and adjusts the focus bias for obtaining the just-in focus state between focuses of the object lens and a focusing error signal.

The data storing section 600 stores the data of the jitter detected by the jitter detecting section 400. As to another example, the data storing section 600 stores a focus bias value, with being turned into a table-up data, capable of minimizing the

jitter by a predetermined range of the jitter. In this case, the variation data of the focus bias voltage related to each range of the jitters should be obtained by a large number of experiments in advance.

Next, methods for adjusting the focus bias of the optical disc player will be explained with reference to FIGs. 3 to 6. The methods are carried out by the above mentioned apparatus.

Referring to FIGs. 2 and 3 in which the latter one is a flowchart illustrating a first embodiment of the methods, the first embodiment of the methods will be explained below. First of all, if the optical disc is loaded into the optical disc player 300 (step S102), the system controller 200 controls the focus bias adjusting section 500 to adjust the focus bias to set by a reference focus bias voltage F(P). The focus bias adjusting section 500 provides the reference focus bias voltage F(P) for an actuator coil (not shown) of the optical pick-up unit 320 by means of the control of the system controller 200. Next, the focus bias voltage is provided for an actuator coil of optical pick-up unit 320, but any descriptions about this will be left out (step S104).

Then, for detecting the jitter, the system controller 200 controls the optical disc player 300 to reproduce the optical disc, loaded into the optical disc player 300, during a first period .

While the first period during which the optical disc player 300 drives the optical disc by means of the control of the system controller 200 reads out a reproduction signal from the optical disc, and provides the reproduction signal to jitter detecting section 400 (step S106). At this time, in the referred embodiment of present invention, it is possible to play back of a table of contents (TOC) section to detect jitter.

The jitter detecting section 400 detects a first jitter J(P) from the reproduction signal supplied by the optical disc player 300, and provides information about the detected first jitter J(P) for the system controller 200 (step S108).

The system controller 200 stores this information about the detected first jitter J(P) in a memory of the data storing section 600 or in the system controller 200, and controls the focus bias adjusting section 500 to adjust the focus bias to be set at a maximum voltage F(M) out of the range of variable quantities of the focus bias

voltages. The focus bias adjusting section 500 provides the maximum focus bias voltage F(M) for the optical pick-up unit 320 installed in the optical disc player 300 by means of the control of the system controller 200 (step S110).

During a following period, a second jitter J(M) can be detected by the steps identical with those for the first jitter. Information about the detected second jitter J(M) is provided for the system controller 200 (step S112).

Next, the system controller 200 subtracts the first jitter J(P), stored in step S108, from the second jitter J(M) which is provided by the jitter detecting section 400 to calculate a jitter deviation E (step S114).

The system controller 200 refers to a table of a data concerning a variation of the focus bias to the jitter deviation (E) stored in the storing section 600 as shown in following Table 1.

With reference to Table 1, the system controller 200 controls the focus bias adjusting section 500 to change the focus bias as much as the variation corresponding to the deviation range in which the jitter deviation E calculated in step S114 is included.

(Table 1)

Jitter deviation (E)	Focus bias variation
$E \geq a$	S1
$a > E \geq b$	S2
$b > E \geq c$	S3
$c > E \geq d$	S4
. . . .	. . . .

Further, the focus bias adjusting section 500 provides the optical pick-up unit 320 with a focus bias voltage F(P1) to which the focus bias is updated as much as the variation corresponding to the range of the jitter deviation by means of the control of system controller 200 (step S116).

Next, to detect a new jitter the system, the controller 200 controls the optical disc player 300 to play back the optical disc loaded into the optical disc player 300 during a next period. At a focus bias voltage of the updated focus bias voltage F(P1), the optical disc player 300 reads out the reproduction signal from the optical disc by

the time for the playback, and provides the reproduction signal for the jitter detecting section 400 by means of the control of the system controller 200 (step S118).

With being provided by the optical disc player 300 with the reproduction signal, the jitter detecting section 400 detects a third jitter J(P1) through the reproduction signal, and provides information about the detected third jitter J(P1) for the system controller 200 (step S120). The system controller 200 compares the third jitter J(P1) provided by the jitter detecting section 400 in step S120 with the first jitter J(P) stored in step S108 (step S122).

In consequence of the comparison in step S122, the system controller 200 recognizes the event that the third jitter is greater than the first jitter as a just-in-focus state that the current focus bias is optimally adjusted, and controls the focus bias adjusting section 500 to adjust the focus bias to the present focus bias voltage. The focus bias adjusting section 500 provides the current focus bias voltage F(P1) for the optical pick-up unit 320 loaded into the optical disc player 300 by means of the control of the system controller 200, and maintains this state (step S124).

On the other hand, if the comparison in step S122 results in the event that the third jitter J(P1) is smaller than the first jitter J(P), the system controller 200 recognizes this event as an out-of-focus state that the present focus bias adjustment is not optimal, and controls the control/overall? operations of the optical disc player 300 to repeat steps S114 to S122 until the third jitter J(P1) becomes greater than the first jitter J(P).

As above, the first embodiment of the present invention can improve convenience and confidence in adjusting the focus bias value by automatically setting the focus bias voltage after corresponding to the focus bias deviation.

FIG. 4 is a flowchart illustrating a method for automatically adjusting the focus bias of the optical disc player according to the second embodiment of the present invention.

Referring to FIGs. 2 and 4, the method for auto-adjusting a focus bias according to the second embodiment of the present invention will be explained as follows.

Above all things, if the optical disc is loaded into the optical disc player 300 (S202), to detect the jitter of the optical disc player 300, the system controller 200

controls the optical disc player 300 to reproduce this disc loaded into the optical disc player during a predetermined time. Then, by means of the control of the system controller 200, the optical disc player 300 reproduces the optical disc during the predetermined time, detects RF signals from the optical disc, and provides the detected RF signal for the jitter detecting section 400 (step S204). The jitter detecting section 400 detects a jitter (Jn) from the RF signals provided by the optical disc player 300, and provides the detected jitter (Jn) for the system controller 200 (step S206).

The system controller 200, with reference to the data of focus bias values against the magnitude of jitters stored in the data storing section 600, searches a focus bias value (Fbn) against the jitter (Jn) which is identical with the detected jitter (Jn) from the jitter detecting section 400, and then controls the focus bias adjusting section 500 to perform the bias adjustment by using the searched focus bias value (Fbn) (step S208). In the data storing section 600, each focus bias value is a voltage value capable of minimizing the jitter in each range of jitters. For instance, a jitter Δt against a focus bias value (V) can be stored, like following Table 2, by carrying out many experiments.

(Table 2)

Jitter range (Δt)	Focus bias value (V)
$J_0 \sim J_1$	F_{b1}
$J_1 \sim J_2$	F_{b2}
$J_2 \sim J_3$	F_{b1}
$J_3 \sim J_4$	F_{b4}
....	....
$J_{n-1} \sim J_n$	F_{bn}
....	....

The focus bias adjusting section 500 provides a detected focus bias value from step S208 for the actuator coil that is equipped with the optical pick-up unit 320 by the control of the system controller 200 (step S210). Accordingly, the actuator coil corresponding to the focus bias voltage can reduce the jitter by carrying out the focus

servo, while moving/maintaining the object lens (not shown) close to or remote from a signal surface of the optical disc. In detail, if the jitter, detected by the jitter detecting section 400 in step S206, is one of the values out of the jitter range in Table 2, for example, J1 to J2, after detecting a second focus bias value corresponding to the jitter range from J1 to J2, then the system controller 200 controls the focus bias adjusting section 500 by using the second focus bias value (Fb2).

The focus bias adjusting section 500, by means of the control of the system controller 200, provides the second bias value F_{b2} for the actuator coil (not shown) that is equipped with optical pick-up unit 320. This actuator coil can reduce the jitter by performing the focus servo, while moving the object lens close to or remote from the surface of the optical disc and responding to the focus bias voltage.

According to the above second embodiment, the focus bias can be adjusted, without detecting the jitter at the variation of the focus bias one by one, by directly searching the focus bias voltage capable of minimizing the jitter in the data storing section and by adjusting the optical disc player's focus bias by the searched focus bias voltage. By doing this, the time for adjusting the focus bias can be shortened.

FIG. 5 is a flowchart depicting the third embodiment of a method for auto-adjusting a focus bias of the optical disc player. FIG. 6 is a graph showing a jitter responding to the variation of the focus bias voltage. In FIG. 6, A and B represent a positive and a negative maximum jitters respectively. When the focus bias values are decreased by a predetermined value, A' and B' represent the focus bias voltages of the positive maximum jitter and the negative maximum jitter respectively. The ΔA and ΔB represent a positive and a negative variable quantities of the jitter respectively.

Referring to FIGs. 2, 5 and 6, the method for auto-adjusting a focus bias according to the third embodiment of the present invention will be explained below.

First of all, if the optical disc is loaded into the optical disc player 300 (S302), the system controller 200 searches information about a jitter detected from each of the focus bias voltages stored, by being turned into a table, in the data storing section 600, reads out a first focus bias voltage F(A) from which the positive of the maximum jitter (A) is detected and a second focus bias voltage F(B) at/from which the negative of the maximum jitter (B) is detected, and stores the voltages of F(A)

and F(B) in the data storing section 600 or in the inner memory (step S304).

Next, the system controller 200 controls the focus bias adjusting section 500 to adjust the focus bias to the third focus bias voltage F(A') that is increased as much as a predetermined voltage established in the first focus bias voltage F(A) and stored in step S304. The focus bias adjusting section 500 provides the third focus bias voltage F(A') for the actuator coil by the control of the system controller 200 (step S306).

For detecting the jitter, the system controller 200 controls the optical disc player 300 into which the optical disc is loaded to playback the optical disc during a predetermined time. In the state that the focus bias is adjusted to the third focus bias voltage F(A') by the control of the system controller 200, the optical disc player 300 provides the jitter detecting section 400 with the reproduction signals that were read out from the optical disc reproduced during a predetermined time. (step S308). At this time, it is possible to play back a table of contents (TOC) section to detect the jitter in the preferred embodiment of the present invention.

The jitter detecting section 400 detects a first jitter J(A') by means of the reproduction signal supplied by the optical disc player 300, and provides information about the detected first jitter J(A') for the system controller 200.

The system controller 200, after storing information about the first jitter J(A') in the inner memory of the system controller 200 or in the data storing section 600 (step S310), controls the focus bias adjusting section 500 to adjust the focus bias to the fourth bias voltage F(B') increased by a determined voltage from the second focus bias voltage F(B) stored in step S304. The focus bias adjusting section 500 provides the maximum focus bias voltage for the optical pick-up unit loaded into the optical disc player 300 by the control of the system controller 200 (step S312).

Next, to detect the jitter, this system controller 200 controls the optical disc player 300 to reproduce the optical disc during a predetermined time. The optical disc player 300, after reading out a reproduction signal from the optical disc that is reproduced within a predetermined time while adjusting to the focus bias voltage by the control of the system controller 200, provides the reproduction signal for the jitter detecting section 400 (step S314).

The jitter detecting section 400 detects a second jitter J(B') by means of the

reproduction signal provided by the optical disc player 300, and provides information about the detected second jitter J(B') for the system controller 200 (step S316).

Then, the system controller 200 calculates the positive jitter variation ΔA by subtracting the third focus bias voltage F(A') from the first focus bias voltage F(A) and the negative jitter variation ΔB by subtracting the fourth focus bias voltage F(B') from the second focus bias voltage F(B) (step S318). Once step S318 is completed, the system controller 200 compares between the positive jitter variation ΔA and the negative jitter variation ΔB each other (step S320).

As a result of the comparison in S320, if the positive jitter variation ΔA is bigger than the negative jitter variation ΔB, the system controller 200 calculates a focus bias voltage F(M) that is an average value of the first and the second focus bias voltages, i.e., F(A) and F(B), and then multiplies the average value by a ratio (ΔB/ΔA) of the negative jitter variation ΔB to the positive jitter variation ΔA. The system controller 200 controls the focus bias adjusting section 500 to adjust the focus bias to a fifth focus bias voltage F(M') which is the production of the average value and the ratio. The focus bias adjusting section 500 provides the fifth focus bias voltage F(M') for the optical pick-up unit 320 by the control of the system controller 200 (step S322).

On the other hand, if another result arises from the comparison in step S320 that the positive jitter variation ΔA is smaller than the negative jitter variation ΔB, the system controller 200 multiplies the average value of the first and the second focus bias voltages, i.e., F(A) and F(B), by a ratio (ΔA/ΔB) of the positive jitter variation ΔA to the negative jitter variation ΔB, and controls the focus bias adjusting section 500 to adjust the focus bias to a sixth focus bias voltage F(M"), which is the production of the average value and the ratio. The focus bias adjusting section 500 provides the sixth focus bias voltage F(M") for the optical pick-up unit 320 by the control of the system controller 200 (step S324).

FIGs. 7a and 7b are flowcharts illustrating a method for auto-adjusting a focus bias of the optical disc player which is a fourth embodiment of the present invention.

After loading the optical disc into the optical disc player 300 (step S402), the optical pick-up unit 320 detects a radio frequency signal from the optical disc, and provides the detected radio frequency signal for the jitter detecting section 400. The

jitter detecting section 400 measures a first jitter J1 from the radio frequency signal, and provides the measured first jitter J1 for the system controller 200 (step S404).

The system controller 200 stores the first jitter J1 in the inner memory (step S406), and compares the first jitter J1 with a reference jitter T (step S408). As a result of the comparison in step S408, if the first jitter J1 is smaller than the reference jitter T, the system controller 200 finishes a focus bias adjusting mode by regarding the focus bias as being adjusted optimally (step S410). On the other hand, if the first jitter J1 is greater than the reference jitter T, the system controller 200 controls the focus bias adjusting section 500 to apply the first bias voltage V1 to the focus servo section 310 (step S412). The focus servo section 310 carries out the focus servo control in the state that the focus bias is adjusted/set by the first bias voltage V1.

The optical pick-up unit 320 detects the radio frequency signal when the focus bias has adjusted at the first voltage, and provides the radio frequency signal for the jitter detecting section 400 (step S414).

Accordingly, the system controller 200 stores the second jitter J2 in the inner memory (step S416), and compares the second jitter J2 with the reference jitter T (step S418). From a result of the comparison in S418 showing that the second jitter J2 is smaller than the reference jitter T, the system controller 200 finishes a focus bias adjusting mode by regarding the focus bias as being adjusted optimally. If the second jitter J2 is smaller than the first jitter from the comparison, the system controller 200 controls the bias adjusting section 500 to provide a second bias voltage (V2 = V1+K1), which is the addition of a predetermined voltage K1 to the first bias voltage V1, for the focus servo section 310 (step S422). The focus servo section 310 performs the focus servo control by means of the focus bias set by the second bias voltage V1.

After adjusting the focus bias to the second bias voltage V2, the optical pick-up unit 320 detects the radio frequency signal, and provides the detected radio frequency signal. The jitter detecting section 400 measures the radio frequency signal to detect a third jitter J3 which corresponds to the second bias voltage V2, and provides the third jitter J3 for the system controller 200 (step S424). The system controller 200 stores the third jitter J3 in the inner memory (step S426), and then compares the third jitter J3 with the reference jitter T (step S428).

From a result of the above comparison showing that the third jitter J3 is smaller than the reference jitter T, the system controller 200 finishes the focus bias adjusting mode by regarding the current focus bias as being adjusted optimally. If the third jitter J3 is greater than the reference jitter T, the system controller 200 compares the second jitter J2 with the third jitter J3 (step S430). If the comparison in step 430 discloses that the third jitter J3 is smaller than the second jitter, the system controller 200 controls the focus bias adjusting section 500 to provide the focus servo section 310 with the third bias voltage that is the addition of half of the predetermined voltage K1 to the second bias voltage V2 (step S432), and finishes the adjustment of the focus bias. On the other hand, if the third jitter J3 is greater than the second jitter J2, the system controller 200 controls the focus bias adjusting section 500 to provide the focus servo section 310 with the fourth bias voltage, which is the subtraction amounting to half of the predetermined voltage K1 from the second bias voltage V2 (step S434), and finishes the adjustment of the focus bias.

Meanwhile, in the event that the second jitter J2 is greater than the first jitter J1 in step S420, the system controller 200 controls the data storing section 600 to provide the fifth bias voltage V5, which is the subtraction of double the predetermined voltage K1 from the first bias voltage V1, for the focus servo section 310 (step S436). The focus servo section 310 performs the focus servo-control with a focus bias set at the fifth bias voltage V5 .

In this condition of the focus bias, the optical pick-up unit 320 detects the radio frequency signal which is provided for the jitter detecting section 400. The jitter detecting section 400 measures the fourth jitter J4, which corresponds to the fifth bias voltage V5, from the radio frequency signal, and provides the fourth jitter J4 for the system controller 200 (step S438). The system controller 200 stores the fourth jitter J4 in the inner memory (step S440), and then compares the fourth jitter J4 with the reference jitter T (step S442). If the comparison in step 442 shows that the fourth jitter J3 is smaller than the second jitter, the system controller 200 finishes the focus bias adjusting mode by treating the focus bias as being optimally adjusted. Otherwise, the system controller 200 performs the comparison of the fourth jitter J4 with the second jitter J2 (step S444).

However, if a result of this comparison shows that the fourth jitter J4 is

smaller than the second jitter J2 in step S444, the system controller 200 controls the focus bias adjusting section 500 to provide the sixth bias voltage V6, which is the addition of half of the predetermined voltage K1 to the fifth bias voltage V5, for the focus bias servo section 310 (step S446), and finishes the focus bias adjustment. If the fourth jitter J4 is smaller than the second jitter J2, the system controller 200 controls the focus bias adjusting section 500 to provide the seventh bias voltage V7, which is the subtraction of half of the predetermined voltage K1 from the fifth bias voltage V5, for the focus bias servo section 310 (step S448), and finishes the focus bias adjustment.

The focus adjustment, according to the above fourth embodiment, can function adaptively to the characteristics of the optical pick-up system by auto-adjusting the focus bias at which the jitter can be minimized with reference to the jitter of the reproduction signal which is read out from an optical disc unit.

Industrial Applicability

In the apparatus and method for automatically adjusting a focus bias voltage in an optical pick-up device, an auto-adjustment for the just-in-focus state can be achieved, and thereby the original signals can be produced by preventing a false action such as a ghost in the output picture and noise occurring in the output sound.

While the present invention has been particularly shown and described with reference to particular embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be effected therein without departing from the spirit and scope of the invention as defined by the appended claims.

What is claimed is:

1. A method for automatically adjusting a focus bias of an optical disc player, the method comprising the steps of:

(i) storing a table-up data of a focus bias variation to a magnitude of a jitter deviation;

(ii) detecting a first jitter which is generated by a predetermined focus bias during a predetermined time for reproducing optical disc information, and storing the first jitter;

(iii) detecting a second jitter which is generated during a predetermined time for reproducing optical disc information after adjusting a focus bias to the maximum of an adjustable value;

(iv) calculating a deviation between the first jitter and the second jitter;

(v) detecting a third jitter after adjusting a focus bias as much as a focus bias variation corresponding to the calculated jitter deviation by referring to the table-up data; and

(vi) adjusting the focus bias with a focus bias value to which is currently applied in the condition that the first jitter has a greater value than that of the third jitter, and otherwise feed backing to the step (iv), from a comparison between the first jitter and the third jitter.

2. A method for automatically adjusting a focus bias of an optical disc player, the method comprises the steps of:

(I) storing a focus bias value, which is a value corresponding to a range of a jitter, capable of minimizing the jitter as a table-up data;

(II) detecting the jitter of the optical disk player by reading out a radio frequency signal from a loaded optical disc;

(III) obtaining, with reference to the table-up data, the focus bias value corresponding to the jitter detected in step (I); and

(IV) adjusting the focus bias of the optical disk player by using the focus bias value obtained in step (III).

3. A method for automatically adjusting a focus bias of an optical disc player, the method comprises the steps of:

(A) storing a table-up data of a jitter magnitude corresponding to each of multiple focus bias voltages;

(B) searching for a first focus bias voltage in which a positive maximum jitter is detected from the table-up data, decreasing the first focus bias voltage as a predetermined voltage to adjust the focus bias, and detecting a first jitter;

(C) searching for a second focus bias voltage in which a negative maximum jitter is detected from the table-up data, increasing the second focus bias voltage as a predetermined voltage to adjust the focus bias, and detecting a second jitter;

(D) calculating an average focus bias value of the first focus bias voltage and the second focus bias voltage;

(E) calculating a positive jitter variation which is a difference between the positive maximum jitter and the first jitter, and calculating a negative jitter variation which is a difference between the negative maximum jitter and the second jitter; and

(F) amending the average focus bias value, capable of reducing a detected jitter, by using the positive jitter variation and the negative jitter variation, and adjusting the focus bias with the amended focus bias voltage.

4. The method as claimed in claim 3, wherein said step (F) comprises the substeps of an amending focus bias voltage by multiplying said arithmetical mean of a focus bias voltage by a first variation in the ratio of a negative jitter variation to a positive jitter variation in a condition that said positive jitter variation is greater than said negative jitter variation, while amending the focus bias voltage by multiplying said arithmetical mean of the focus bias voltage by a second jitter variation in the ratio of the positive jitter variation to the negative jitter variation in a condition that said positive jitter variation is smaller than said negative jitter variation.

5. A method for automatically adjusting a focus bias of an optical disc player, the method comprises the steps of :

(a) providing a focus servo circuit with a first focus bias voltage in the event that a first jitter of a radio frequency signal, which is detected first after loading an

optical disc, is greater than a reference jitter, and detecting a second jitter of the radio frequency signal corresponding to the first focus bias voltage;

(b) providing the focus servo circuit with a second focus bias voltage in which a predetermined voltage is added to the first focus bias voltage in the event that the second jitter is greater than the reference jitter and that the first jitter is greater than the second jitter, and detecting a third jitter of the radio frequency signal corresponding to the second focus bias voltage;

(c) setting a third focus bias voltage, as a focus bias voltage, which is an addition of half of the predetermined voltage to the second bias voltage in the event that the third jitter, detected in step (b), is greater than the reference jitter and that the second jitter is greater than the third jitter, and setting a fourth focus bias voltage, as a focus bias voltage, which is an subtraction of half of the predetermined voltage from the second bias voltage in the event that the third jitter, detected in step (b), is greater than the reference jitter and that the second jitter is smaller than the third jitter;

(d) providing the focus servo circuit with a fifth bias voltage which is a subtraction of double the predetermined voltage from the first bias voltage in the event that the second jitter is greater than the reference jitter and that the first jitter is smaller than the second jitter, and detecting a fourth jitter of the radio frequency signal which corresponds to the provided fifth bias voltage;

(e) setting a sixth focus bias voltage, as a focus bias voltage, which is an addition of half of the predetermined voltage to the fifth bias voltage in the event that the fourth jitter, detected in step (d), is greater than the reference jitter and that the second jitter is greater than the fourth jitter, and setting a seventh focus bias voltage, as a focus bias voltage, which is an subtraction of half of said predetermined voltage from said fifth bias voltage in the event that the fourth jitter, detected in step (d), is greater than the reference jitter and that the second jitter is smaller than the fourth jitter; and

(f) setting each of bias voltages, as a focus bias voltage, which corresponds to the first to the fourth jitters in the event that each of the first to the fourth jitters is smaller than the reference jitter in steps (a) to (e).

6. An apparatus for automatically adjusting a focus bias of an optical disc player, the apparatus comprising:

a key input means;

an optical disc player, outputting a reproduction signal, including an optical pick-up section for detecting data and a focus servo section for focusing a servo corresponding to a voltage level of a focus error signal after detecting the focus error signal from an electric signal that controls the focus servo means and that is outputted from the optical pick-up means;

a jitter detecting means for detecting a jitter that is a data detecting an error caused by adjusting an incorrective focus bias from said reproducing signal provided by said optical disc player;

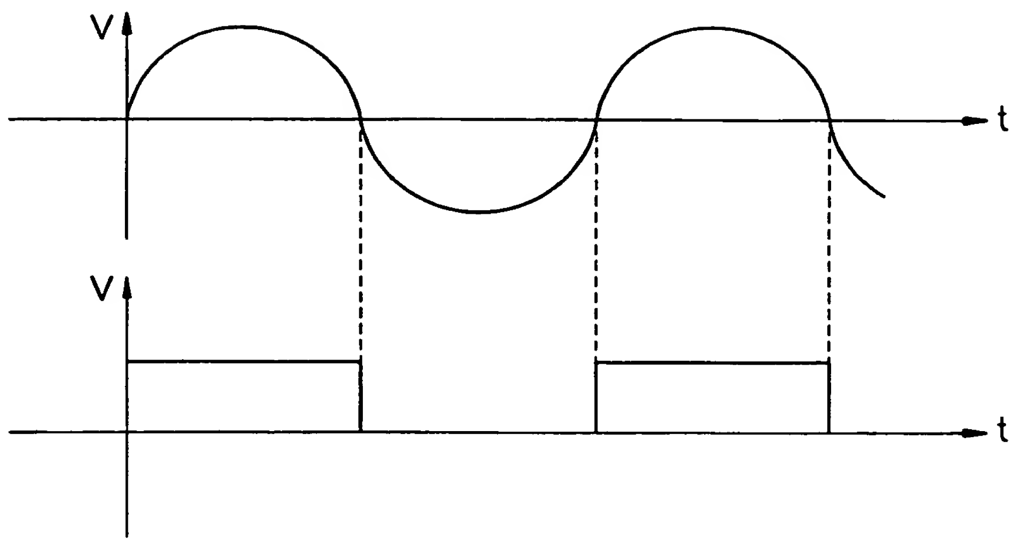
a focus bias adjusting means for adjusting a focus bias to match a signal surface of an optical disc in a focus depth of a laser beam of said pick-up means by providing a predetermined bias voltage for said optical pick-up means; and

a system control means for controlling said optical disc player that corresponds to the signal provided by said key input means and said jitter detecting means.

7. The apparatus as claimed in claim 6, which further comprises a storing means for storing the jitter detected from said jitter detecting means.

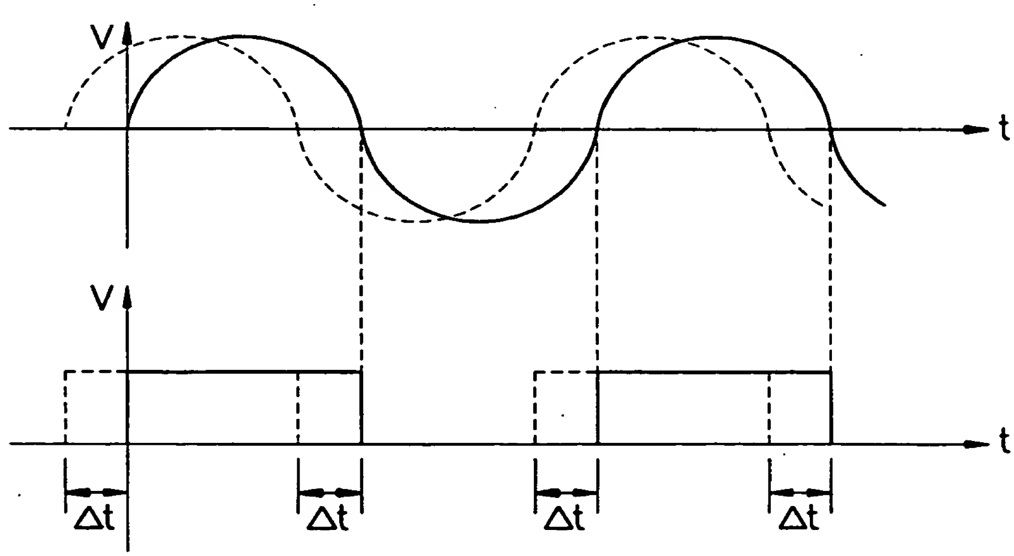
8. The apparatus as claimed in claim 6, which further comprises a storing means which stores a table-up data of a focus bias value which is capable of minimizing the jitter with a determined range.

FIG. 1A



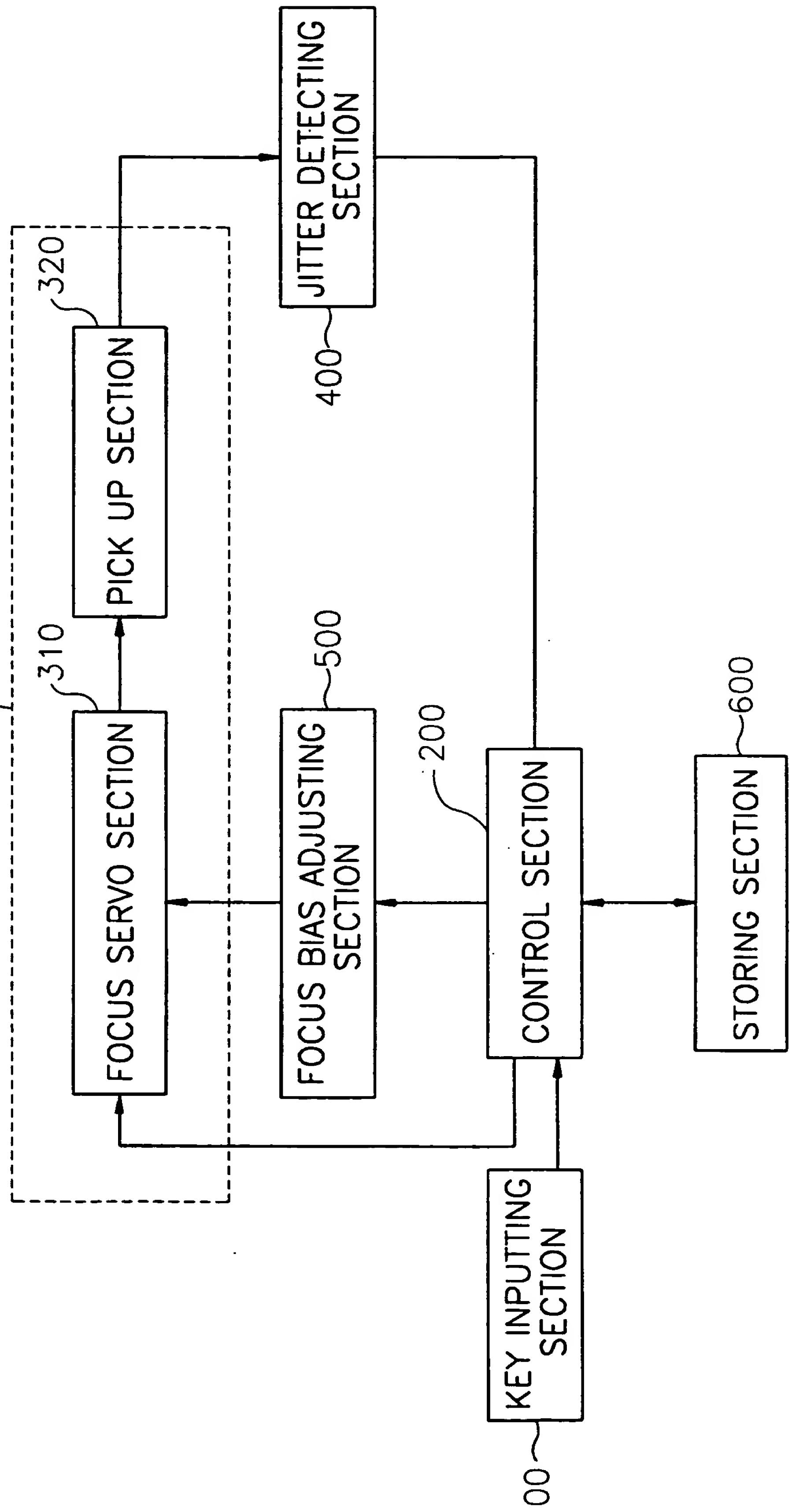
(JUST-IN-FOCUS STATE)

FIG. 1B



(OUT-OF-FOCUS STATE)

FIG. 2



JITTER DETECTING SECTION
400
320
PICK UP SECTION
300
310
FOCUS SERVO SECTION
FOCUS BIAS ADJUSTING SECTION
500
200
CONTROL SECTION
STORING SECTION
600
KEY INPUTTING SECTION
100

FIG. 3

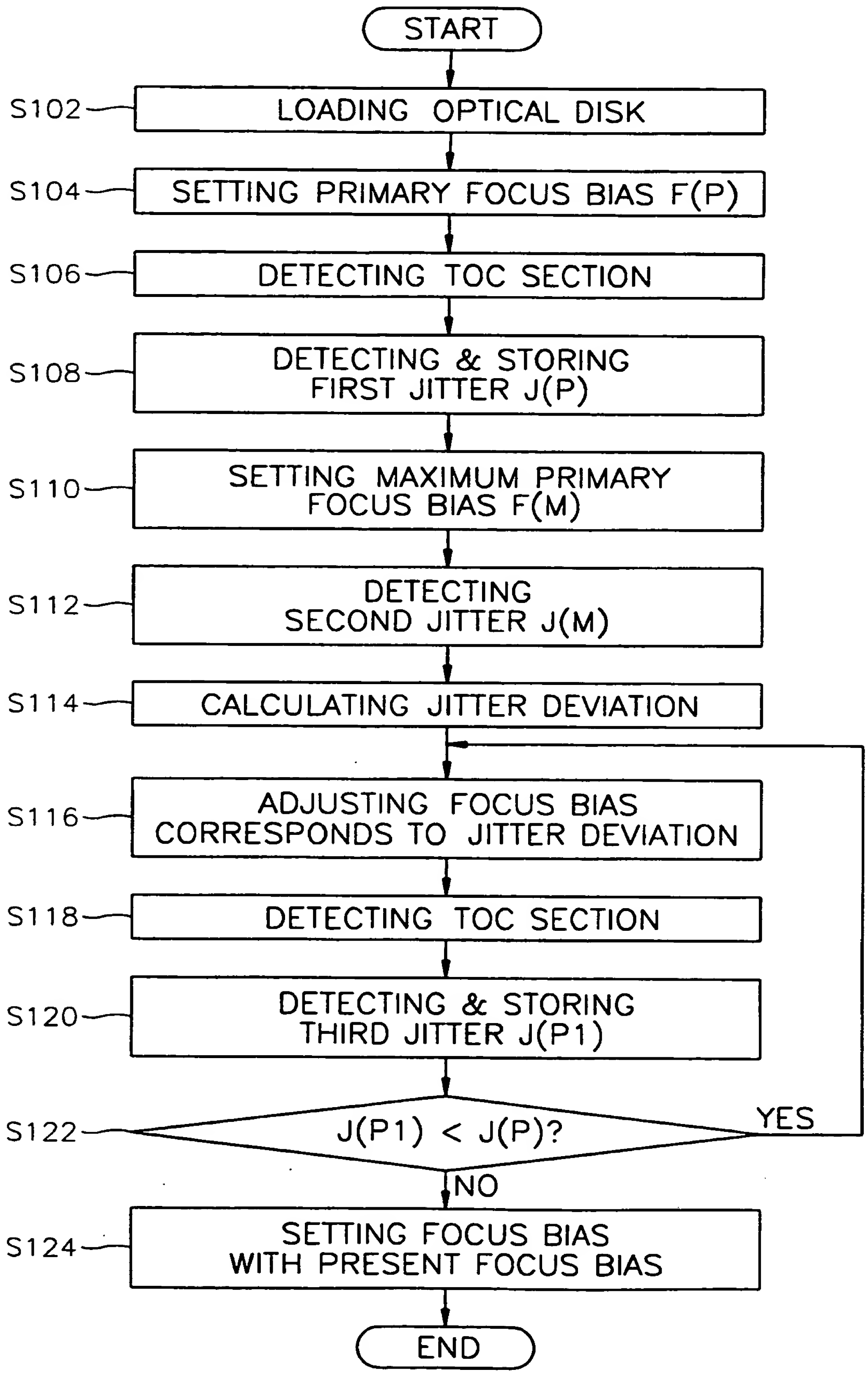

START
S102
LOADING OPTICAL DISK
S104
SETTING PRIMARY FOCUS BIAS F(P)
S106
DETECTING TOC SECTION
S108
DETECTING & STORING FIRST JITTER J(P)
S110
SETTING MAXIMUM PRIMARY FOCUS BIAS F(M)
S112
DETECTING SECOND JITTER J(M)
S114
CALCULATING JITTER DEVIATION
S116
ADJUSTING FOCUS BIAS CORRESPONDS TO JITTER DEVIATION
S118
DETECTING TOC SECTION
S120
DETECTING & STORING THIRD JITTER J(P1)
S122
J(P1) < J(P)?
YES
NO
S124
SETTING FOCUS BIAS WITH PRESENT FOCUS BIAS
END

FIG. 4

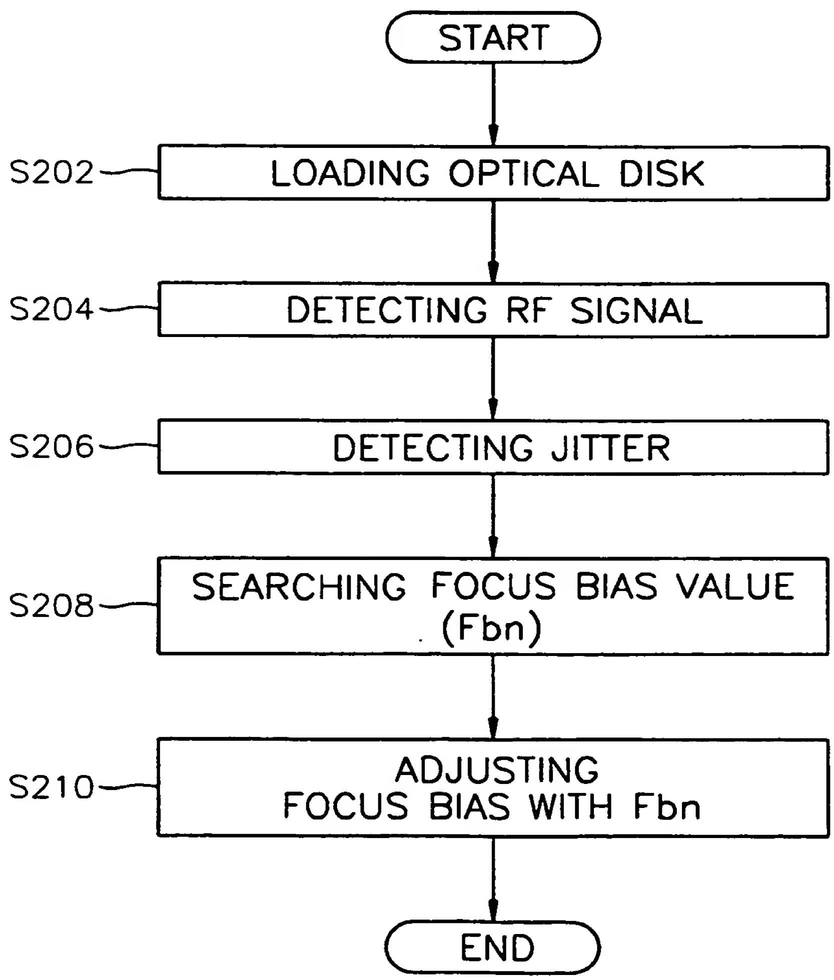

START
S202
LOADING OPTICAL DISK
S204
DETECTING RF SIGNAL
S206
DETECTING JITTER
S208
SEARCHING FOCUS BIAS VALUE (Fbn)
S210
ADJUSTING FOCUS BIAS WITH Fbn
END

FIG. 5

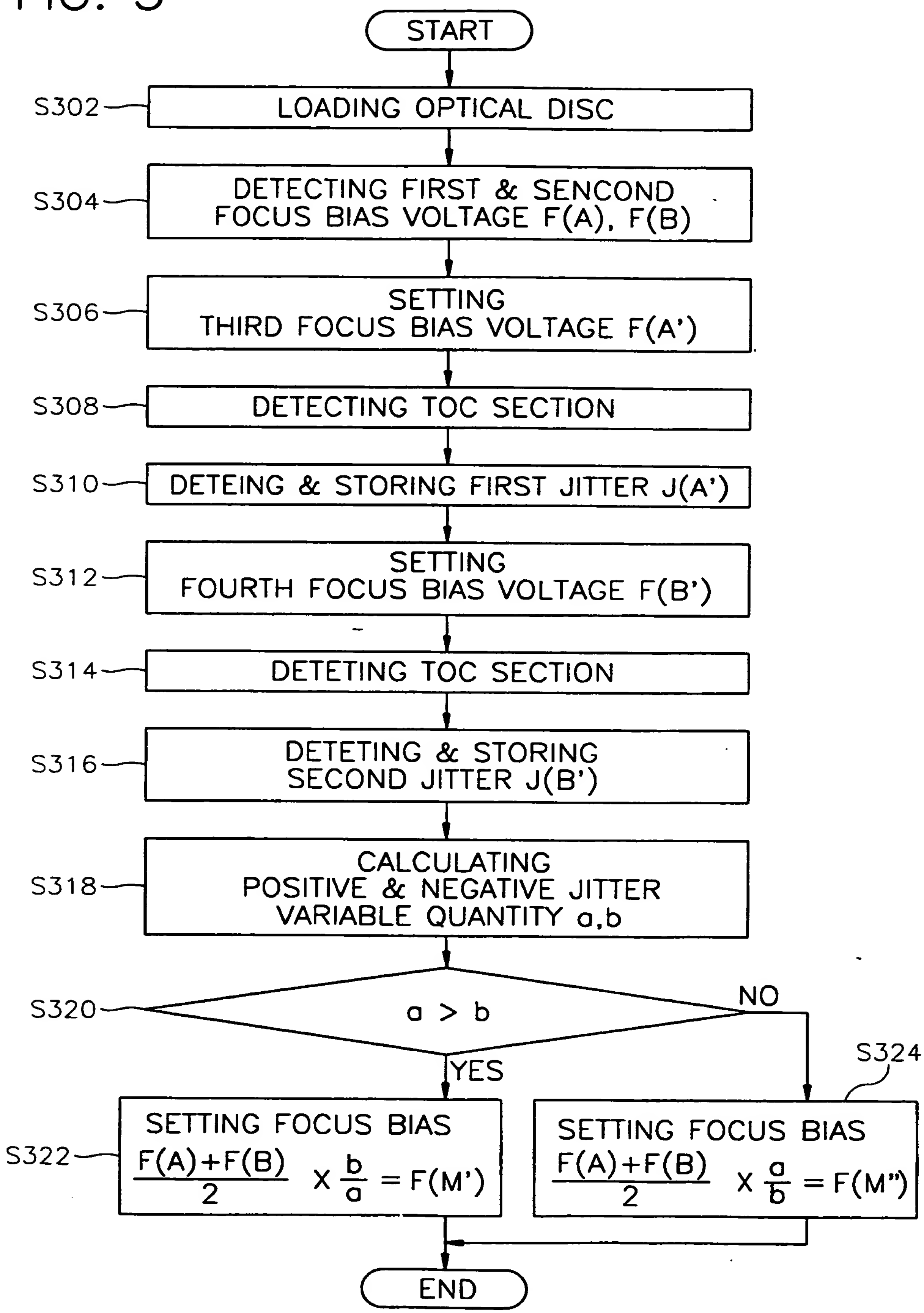

START
S302
LOADING OPTICAL DISC
S304
DETECTING FIRST & SENCOND FOCUS BIAS VOLTAGE F(A), F(B)
S306
SETTING THIRD FOCUS BIAS VOLTAGE F(A')
S308
DETECTING TOC SECTION
S310
DETEING & STORING FIRST JITTER J(A')
S312
SETTING FOURTH FOCUS BIAS VOLTAGE F(B')
S314
DETETING TOC SECTION
S316
DETETING & STORING SECOND JITTER J(B')
S318
CALCULATING POSITIVE & NEGATIVE JITTER VARIABLE QUANTITY a,b
S320
a > b
NO
YES
S322
SETTING FOCUS BIAS $\frac{F(A)+F(B)}{2} \times \frac{b}{a} = F(M')$
S324
SETTING FOCUS BIAS $\frac{F(A)+F(B)}{2} \times \frac{a}{b} = F(M'')$
END

FIG. 6

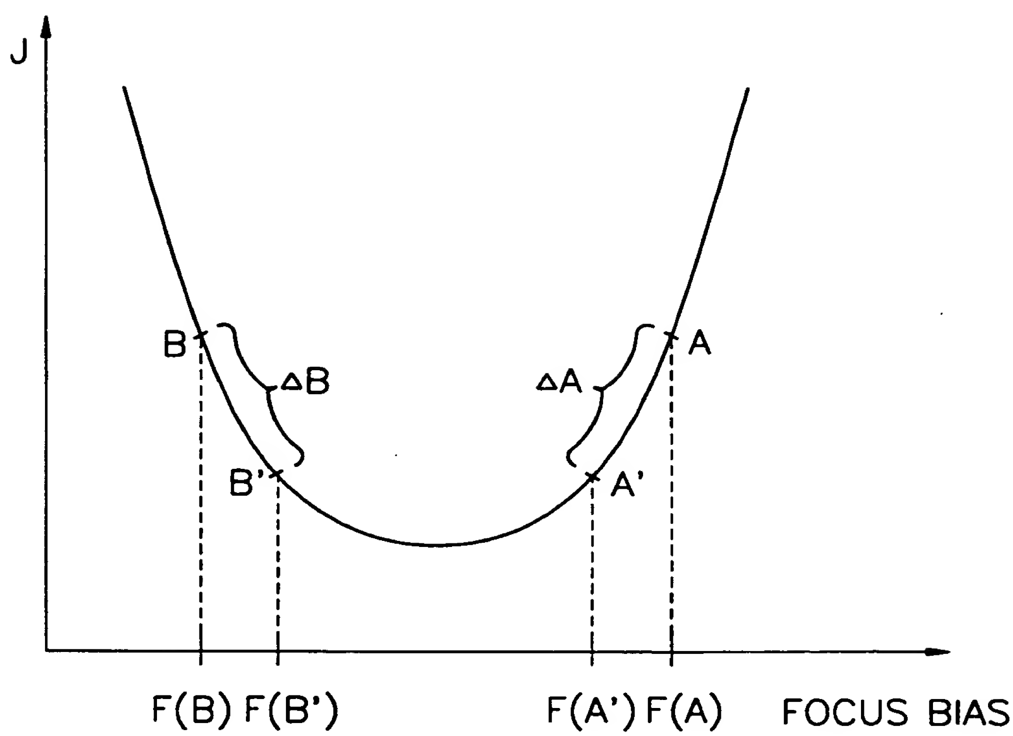
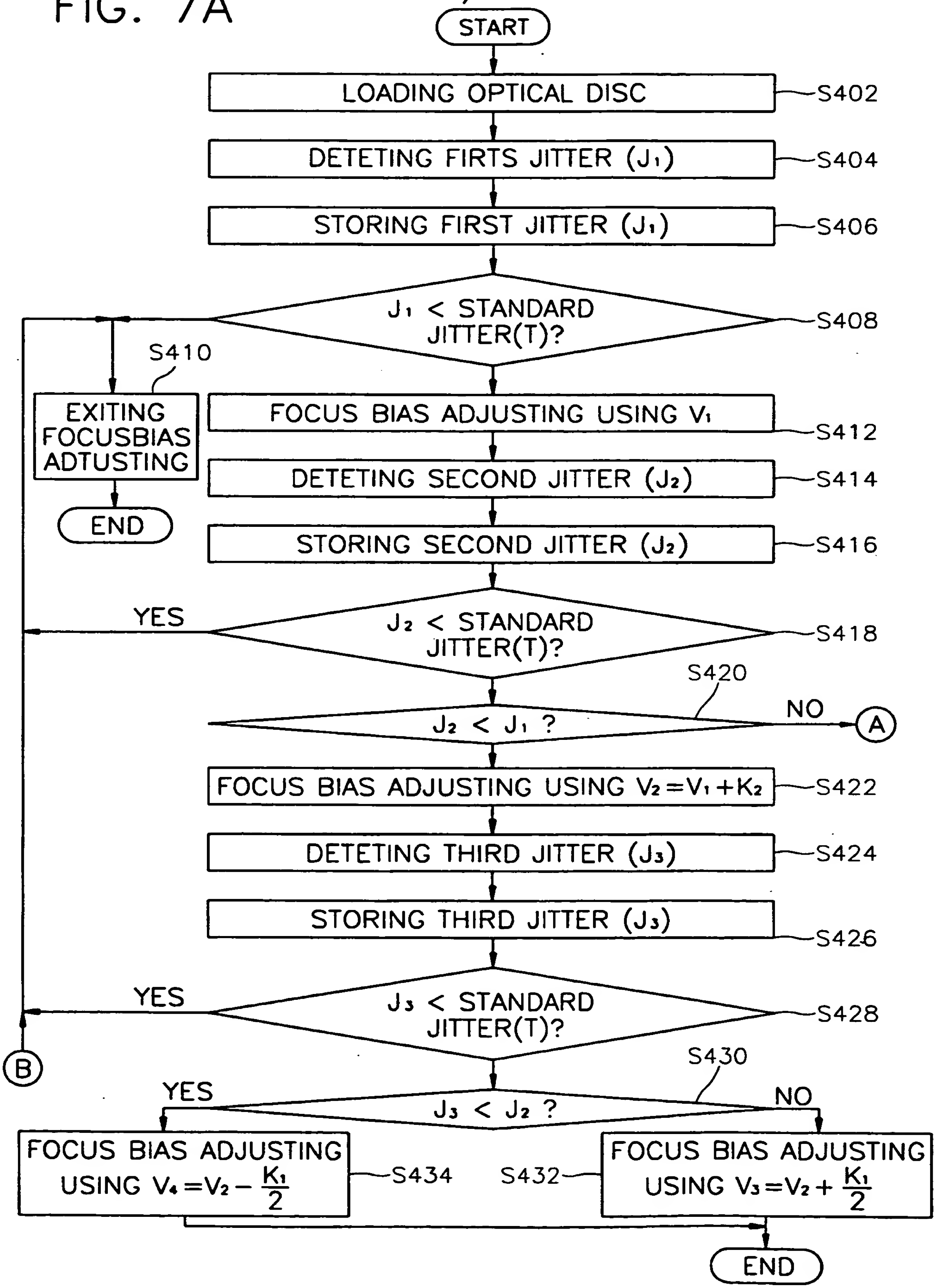
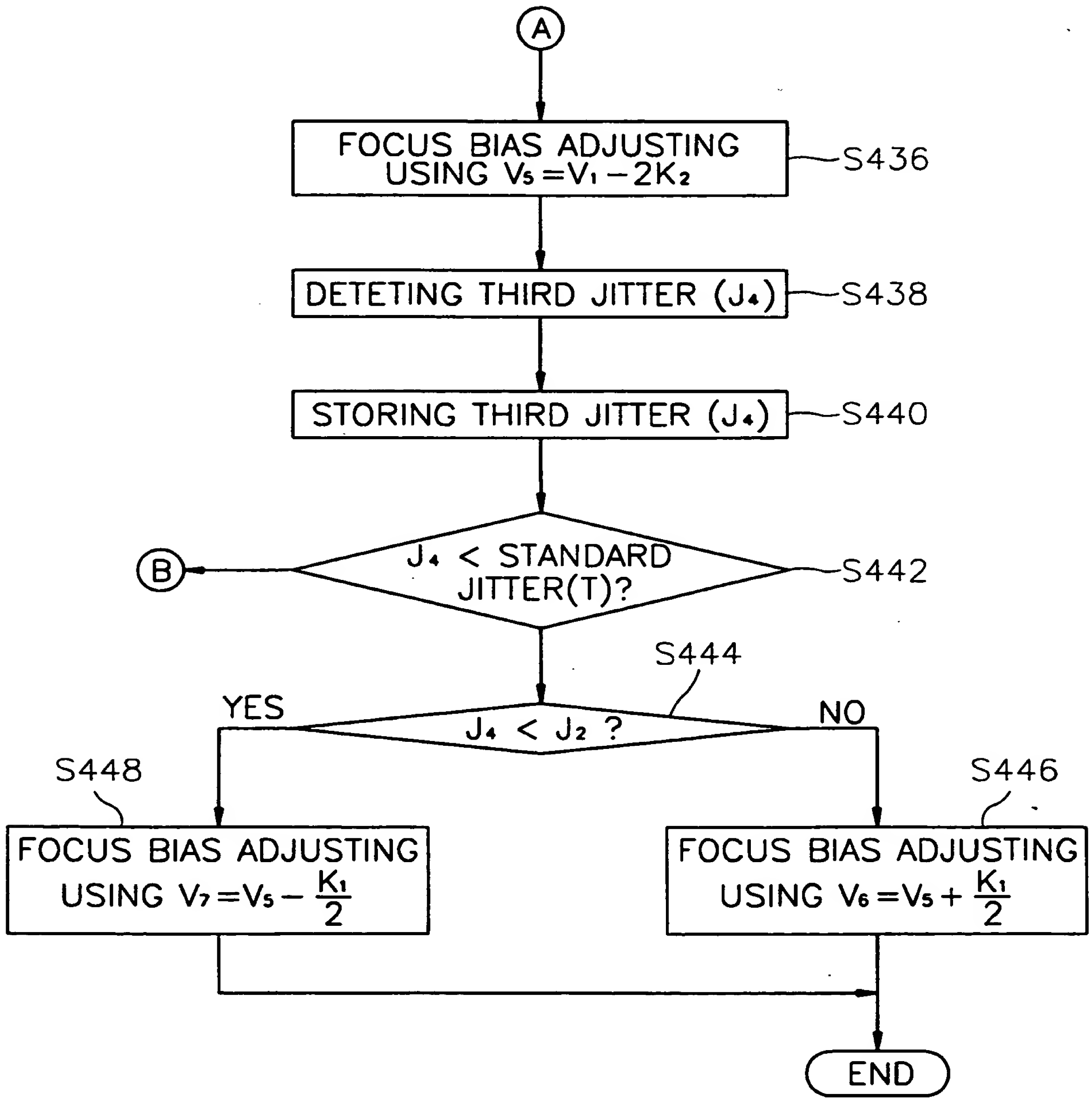


FIG. 7A



START
LOADING OPTICAL DISC
S402
DETETING FIRTS JITTER (J_1)
S404
STORING FIRST JITTER (J_1)
S406
J_1 < STANDARD JITTER(T)?
S408
S410
EXITING FOCUSBIAS ADTUSTING
END
FOCUS BIAS ADJUSTING USING V_1
S412
DETETING SECOND JITTER (J_2)
S414
STORING SECOND JITTER (J_2)
S416
YES
J_2 < STANDARD JITTER(T)?
S418
S420
$J_2 < J_1$?
NO
A
FOCUS BIAS ADJUSTING USING $V_2=V_1+K_2$
S422
DETETING THIRD JITTER (J_3)
S424
STORING THIRD JITTER (J_3)
S426
YES
J_3 < STANDARD JITTER(T)?
S428
B
S430
YES
$J_3 < J_2$?
NO
FOCUS BIAS ADJUSTING USING $V_4=V_2-\frac{K_1}{2}$
S434
S432
FOCUS BIAS ADJUSTING USING $V_3=V_2+\frac{K_1}{2}$
END

FIG. 7B


A
FOCUS BIAS ADJUSTING USING V5=V1-2K2
S436
DETETING THIRD JITTER (J4)
S438
STORING THIRD JITTER (J4)
S440
J4 < STANDARD JITTER(T)?
S442
B
S444
J4 < J2 ?
YES
NO
S448
FOCUS BIAS ADJUSTING USING V7=V5-K1/2
S446
FOCUS BIAS ADJUSTING USING V6=V5+K1/2
END

INTERNATIONAL SEARCH REPORT

Inter. ..ional application No.
PCT/KR 98/00281

A. CLASSIFICATION OF SUBJECT MATTER

IPC^6: G 11 B 7/09,7/00,11/10,13/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC^6: G 11 B 7/00,11/00,13/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPIL

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	Patent Abstracts of Japan, Vol.97, No.6, 1997, JP 09-044864 A (KENWOOD CORP.) 30 June 1997 (30.06.97).	1-8
A	EP 0 586 084 A2 (SONY CORP.) 09 March 1994 (09.03.94), fig.4,5; abstract; column 2, lines 37-40.	1-8
A	EP 0 423 731 A2 (MATSUSHITA ELECTRIC IND. CO., LTD.) 24 April 1991 (24.04.91), fig.1; abstract; claim 1.	1

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

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"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
16 November 1998 (16.11.98)	17 December 1998 (17.12.98)
Name and mailing address of the ISA/ Austrian Patent Office Kohlmarkt 8-10; A-1014 Vienna Facsimile No. 1/53424/535	Authorized officer Berger Telephone No. 1/53424/453

INTERNATIONAL SEARCH REPORT

Information on patent family members

Intern. onal application No.
PCT/KR 98/00281

Im Recherchenbericht angeführtes Patentdokument / Patent document cited in search report / Document de brevet cité dans le rapport de recherche	Datum der Veröffentlichung / Publication date / Date de publication	Mitglied(er) der Patentfamilie / Patent family member(s) / Membre(s) de la famille de brevets	Datum der Veröffentlichung / Publication date / Date de publication
EP A2 586084	09-03-94	DE C0 69317831	14-05-98
		DE T2 69317831	06-08-98
		DE C0 69320997	15-10-98
		EP A3 586084	03-08-94
		EP A1 782133	02-07-97
		EP B1 586084	08-04-98
		EP B1 782133	09-09-98
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		JP A2 6103600	15-04-94
EP A2 423731	24-04-91	DE C0 69027275	11-07-96
		DE T2 69027275	02-10-96
		EP A3 423731	03-03-93
		EP B1 423731	05-06-96
		JP A2 3130972	04-06-91
		KR B1 9303546	23-04-94
		US A 5268883	07-12-93

Form PCT/ISA/210 (patent family annex) (July 1998)